ground against which the shadow is projected. Taking the effective diameter of the shadow at 2100 miles, we find from equation (1) that the actual length of the shadow near the terminator is about 14,500 miles, and the chord is inclined to the planet's radius-vector 9°.5. When *Jupiter* is in quadrature, θ is something over 11°; therefore, the chord 14,500 miles long is seen under the maximum angle 20.5. Consequently, its length projected on a plane normal to the line of sight is more than 5000 miles, or more than twice the vertical diameter of the shadow. When the shadow(complete) is internally tangent to the *full* outline of the planet, the observed horizontal diameter of the planet is, for the same value of θ, but little more than one-fourth of the observed vertical diameter. It is probable that the assumed effective diameter, 2100 miles, is much too large for the shadow. If a less value is used, the distortion becomes increasingly greater. If the transit is not central, the distortions will be oblique near the terminators, and on the central meridian the axes will be slightly unequal. The exact geometrical form can now, of course, be predicted.*

PHOTOGRAPHIC VERIFICATION OF THE MOST DELICATE OPTICAL DETAILS ON THE MOON.

By Professor L. Weinek.†

Professor L. Weinek, Director of the Imperial Observatory of Prague, has submitted to the Imperial Academy of Sciences of Vienna, as a continuation of his recent lunar studies, drawings of the ring-plane *Capella* and of the crater *Taruntius* C, enlarged forty times from photographs taken at the Lick Observatory. His explanatory remarks are as follows:

Drawings I and II represent the interior of the ring-plane *Capella;* drawings III, IV and V show the small crater on the north wall of *Taruntius*, which Maedler calls C.

* When the elongated shadow falls centrally upon a very narrow bright belt or spot, an apparent contraction of the penumbral portion of the shadow will have a tendency to form an apparent double shadow, especially when the seeing is not first-class. This explanation requires that the two portions of the shadow shall always lie nearly along a radius, or along a line parallel to the circumference. In the former position the shadow will be near the visible terminator and appear larger than in the latter position, which will be near the invisible terminator of the planet. J. M. S.

† Translated for the Society by F. R. Ziel, Secretary and Treasurer of the A. S. P., from the *Sitzungsbericht* of the Imperial Academy of Sciences at Vienna, July 6, 1893.

These five drawings are enlarged exactly forty times from the following photographs taken at the LICK Observatory :

I. From LICK Observatory negative, 1890, November 17.
$6^h\ 8^m\ 35^s$ P. S. T.; moon's age, $= 5^d\ 12.5^h$.

II. From LICK Observatory negative, 1890, August 31.
$14^h\ 27^m$ P. S. T.; moon's age $= 16^d\ 18^h$.

III. From LICK Observatory negative, 1890, November 16.
$5^h\ 53^m$ P. S. T.; moon's age $= 4^d\ 12^h$.

IV. From LICK Observatory negative, 1890, July 20.
$7^h\ 53^m$ P. S. T.; moon's age $= 4^d\ 3^h$.

V. From LICK Observatory negative, 1890, August 31.
$14^h\ 27^m$ P. S. T.; moon's age $= 16^d\ 18^h$.

Both pictures of *Capella*, in which the shadows are cast in opposite directions, have exactly the same position in reference to the Moon's meridian, so that the vertical lines of the reticle represent the direction of the meridian for this locality of the Moon.

The exact orientation was found by turning plates I and II in such a manner that the east crest of *Capella* and the east rim of crater D, northeast of *Capella* (which objects MAEDLER places in almost the same meridian), coincided with one of the vertical lines of the glass reticle, which was divided into spaces of one half-millimetre, and which was used in making the enlargement. In a similar manner the three drawings of the crater *Taruntius* C were located exactly alike, in reference to the meridian of the place, which is also shown by the vertical lines of the picture.*

THE CENTRAL PEAK IN *CAPELLA*.

Mr. C. M. GAUDIBERT of Vaison (Vaucluse), in writing to me on April 27, 1893, calls my attention to a small crater which he discovered on May 24, 1890, on the summit of the central peak in *Capella*, which he describes in the *Revue mensuelle d'Astronomie populaire*, Fevrier, 1892, p. 64, as being excessively small at the time of first observation; but at present he is able to see it without difficulty, so that Mr. GAUDIBERT is led to the belief that this summit-crater may have lately attained a larger diameter.

I was much interested by Mr. GAUDIBERT'S information, and proceeded to search for this crater on LICK Observatory plates of the year 1890, for the purpose of ascertaining whether the photo-

* These pictures will be published in the future.

graphic representation was inferior or superior to the optical observation.

Mr. GAUDIBERT states that during the whole of the year 1890, and until September 20, 1891, although he searched for this crater whenever opportunity offered, he was unable to verify his first observation; which is no doubt a proof that the optical observation of the crater was extremely difficult during the year 1890.

I had no trouble in finding this summit-crater on two plates (I and II) of 1890, with shadows falling in opposite directions, and was, moreover, led to the discovery of several formations of rills and some much smaller craters in the vicinity; the enlargement of 40 diameters (viz.: 0.28 ^{mm} on SCHMIDT'S map = 0.50 ^{km}) shows an exceedingly small crater (having a diameter of only 0.8 ^{mm}) to the east, which is identified on both drawings I and II, as well by its position as by its size.

I may state that the round outline of this minute crater on plate II is of the same order as the lines of the faintest rills discovered photographically. I have found, after making numerous measurements, that the grain of the photographic plate, under an enlargement of 40 diameters, has a size of only 0.10 to 0.17 mil imetres; this agrees well with Professor EDER'S measurements in *Die photographische Camera und die Momentphotographie*, 1892, page, 698, which place the size of the grain of quick dry plates at 0.003 to 0.004 millimetres; so that the grain is about five to eight times smaller than the diameter of the above-mentioned crater.

Plate I shows the summit-crater very clearly, and was taken at about the same age of the Moon as that on which the optical discovery was made, viz., May 24, 1890, the Sun being about 18° above the morning horizon; whereas for plate II the altitude of the Sun was about 28° above the evening horizon. The greater altitude of 10° in the latter case is probably the reason why the crater is not so plainly shown on plate II, where it is hardly more than outlined. The visibility of a crater is naturally also governed by its inner slope toward the west or east, as the case may be, and which is not known beforehand. In general the conditions exhibited on plate I appear to be more favorable for *Capella* than those of plate II.

The small crater discovered by GAUDIBERT on March 15, 1891, on the western slope of the central peak is well visible on

plates I and II; on the former with a distinct round outline without much shadow, on the latter with a shadow.

The first-mentioned manner of photographic representation of small craters is very interesting, and is quite frequently met with on the photographic plate, but as a rule becomes apparent only by strong magnification, and in many cases furnishes the proof of the existence of an optically observed crater, which, owing to the not quite favorable exposure conditions of the plate, had apparently been lost on the latter.

Southeast from the summit, at the base of the peak, there are three larger craters, of which the two outer ones can be identified on plates I and II without difficulty. The middle one, however, is barely visible on plate I, although quite plain on plate II.

Among the many small craters, including some as small as one-sixth of the diameter of the summit-crater on both pictures, which appear principally as perfectly circular outlines, and which can in some cases be traced on plates I and II (on plate I the Moon's distance from the Earth is a little greater than on plate II). We observe on plate II a circle of four distinct craters on the southwest wall of *Capella;* of these the most easterly one is also shown on plate I. A very delicate rill-formation, extending from the summit-crater in a southwesterly direction, and which is finally divided in the shape of a fork, can be identified with certainty on both plates.

Plates I and II show a great number of chains of delicate undulations, low elevations and faint rills, the general direction of which is perpendicular to the Sun. Among these we may mention several chains on the peak itself, which converge toward the summit-crater, and, therefore, probably originate in the latter.

Finally, I may mention that the time employed in the production of drawing I was 20½ hours, and ofdrawing II 25 hours.

Considering this relatively short time of drawing, it was possible, in both cases, only to make an exact drawing of the central peak, while the rest has only been sketched, although it is correct in reference to position and showing all important detail.

TARUNTIUS C.

Plates III and IV, in which the shadows are cast in the same direction, and plate V, in which they fall in the opposite direction, show that there is another smaller crater at the bottom of

this crater, which, on plate V, gives the impression of being slightly convex, and has a small crater opening in its center.

The size and shape of this inner crater agrees well in all three cases.

The diameter along the meridian is equal to 3.5 millimetres, or 2.23 kilometres,* or 0.30 geographical miles on the enlargement of 40 diameters, whereas, the diameter of the inner crater-opening is 0.25 kilometres.†

THE CORDOBA DURCHMUSTERUNG.

By R. H. TUCKER, Jr., Astronomer in the LICK Observatory.

The completion of twenty degrees of the *Cordoba Durchmusterung* marks an epoch in that undertaking. The first ten degrees, from -22° Declination, one degree North of the limit of *Schönfeld's Durchmusterung*, to -32°, forms Volume XVI of the *Cordoba Observations*, and has been already distributed to observatories and astronomers, The remaining ten degrees, to -42° Declination, are in the hands of the printer, and will be included in another volume. The maps to accompany the volumes, giving all the stars of the catalogue, are, some of them, now being lithographed.

The two volumes give the places and magnitudes of more than 340,000 stars down to the tenth magnitude. As the region covered by this section of the *Durchmusterung* is three-tenths of the Southern sky, and but thirty three-hundredths remain to the pole, about half the surface included in the original scheme has been completed.

The observation of the twenty degrees has required five years of effective work for the two observers engaged upon it. During this period more than 1600 individual zones were taken, one hour long at the maximum, and one degree of Declination in width, except in portions of the Milky Way, where but 40′ wide was possible. This covers the lap necessary between succeeding zones in Declination ; the zones broken by clouds, or repeated from suspicion that the sky may not have been per-

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* 1 $\frac{1}{10}$ English miles.

† $\frac{1}{100}$ English miles.